

When three glucose models are joined together, how many molecules of water do the removed end atoms form? \_\_\_\_\_

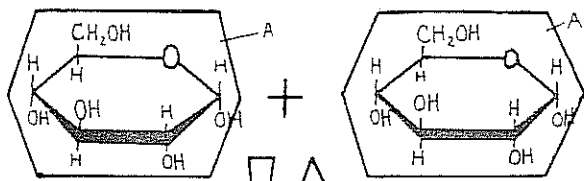
NOTES:

Write the molecular formula for the compound maltose, which results from the joining of two molecules of glucose. (Remember that a molecule of water is removed.) \_\_\_\_\_

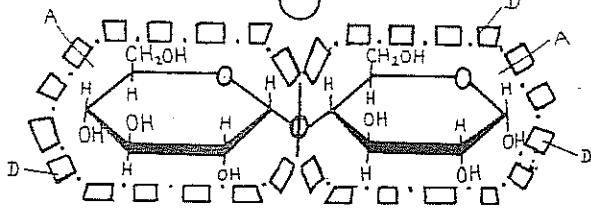
To determine the general molecular formula for starch, subtract the end atoms that were removed from the middle glucose molecule. What is the formula? \_\_\_\_\_

What is the ratio of hydrogen atoms to oxygen atoms in glucose? \_\_\_\_\_  
In starch? \_\_\_\_\_

Complete the following color diagram using the suggested colors. Remember to color the model and the associated term the same color....

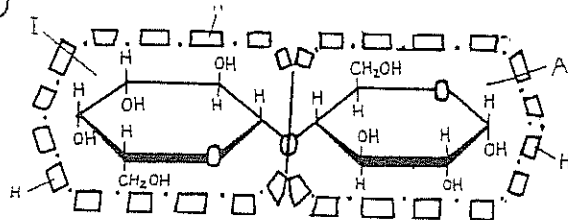
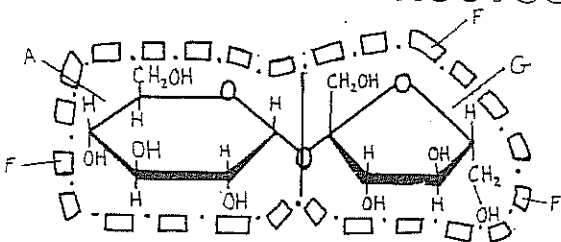


GLUCOSE (MONOSACCHARIDE)<sub>A</sub> } green  
 DEHYDRATION CONDENSATION<sub>B</sub> } red  
 WATER<sub>C</sub> - blue  
 MALTOSE (DISACCHARIDE)<sub>D</sub> } yellow  
 HYDROLYSIS<sub>E</sub> - orange



DISACCHARIDES\*  
 SUCROSE<sub>F</sub> - yellow  
 GLUCOSE<sub>A</sub> + FRUCTOSE<sub>G</sub> (green)

LACTOSE<sub>H</sub> - yellow  
 GALACTOSE<sub>I</sub> + GLUCOSE<sub>A</sub>



completed \_\_\_\_\_

## Lab 2—Is There Carbon in a Carbohydrate?

Both sugars and starches are carbohydrates. Have you ever noticed that when potatoes (starch) are burned, they turn black? This is a chemical property of carbon in the starch. In this investigation, you will determine whether carbon is also present in sugar crystals.

PUT ON YOUR LAB APRON AND SAFETY GLASSES BEFORE BEGINNING THE ACTIVITY.

Place one measure of sugar crystals in a 13 mm X 100 mm culture tube.

Set up and light the Bunsen burner following steps learned in an earlier lab. Hold the culture tube with a test tube holder and place the bottom of the tube in the hottest part of the flame. **KEEP THE MOUTH OF THE TUBE POINTED AWAY FROM YOU AND OTHER LAB PARTNERS WHILE HEATING.** Watch the sugar as you heat it.

What happened to the sugar crystals? \_\_\_\_\_

Continue heating the tube until all that is left is a black residue in the bottom. Based on your knowledge of sugar's chemical composition, what do you think this substance is? \_\_\_\_\_

What happened to the hydrogen and oxygen atoms present in the sugar molecules? \_\_\_\_\_  
\_\_\_\_\_

Once again, add one measure of sugar to a new, clean 13 mm X 100 mm culture tube. On this trial, invert and place the mouth of a 16 mm X 150 mm culture tube over the mouth of the sugar tube. Once again, heat the sample until it "melts"—do not completely dehydrate it. In other words, once the sugar begins to "turn liquid" stop the heating. Place the tube combination on your desk to cool.

After the cooling time, answer the following question. What are the droplets of material in the larger tube? \_\_\_\_\_

Have the results of your three tubes verified by your instructor. Verified \_\_\_\_\_

Place all tubes in the trash, when done.

NOTES:

## Lipids

The word **lipid** refers to any of the members of a group of organic molecules that are soluble in organic solvents, but are not soluble in water. Although lipids include fats, steroids, and phospholipids, this exercise will focus primarily on fats.

**Triglycerides**, a popular topic in discussions of diet and nutrition, are the most common form of fat. They consist of three fatty acids attached to a glycerol molecule (see below). Triglycerides are found predominantly in adipose (more commonly called "fat") tissue and store more energy per gram than any other molecule.

At room temperature, some fats are solid (generally those found in animals) and are referred to as **fats**, while others are liquid (generally those found in plants) and are referred to as "**oils**." Vegetable oil, a liquid fat, is a mixture of triglycerides.

Since both solid and liquid fats are nonpolar, we will test for their presence by using Sudan IV, a nonpolar dye that dissolves in nonpolar substances like fats and oils but not in polar substances such as water.

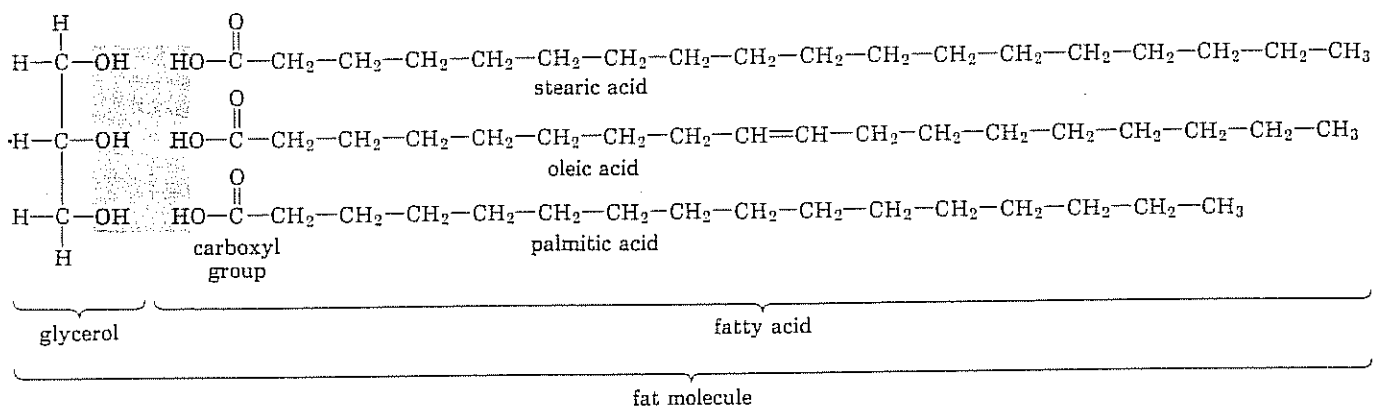


Figure 5B-1 A triglyceride is composed of three fatty acids and a glycerol molecule. Each bond is formed when a molecule of water is removed by condensation (boxed).

Lipid is the official name for \_\_\_\_\_ but also include \_\_\_\_\_ and \_\_\_\_\_.

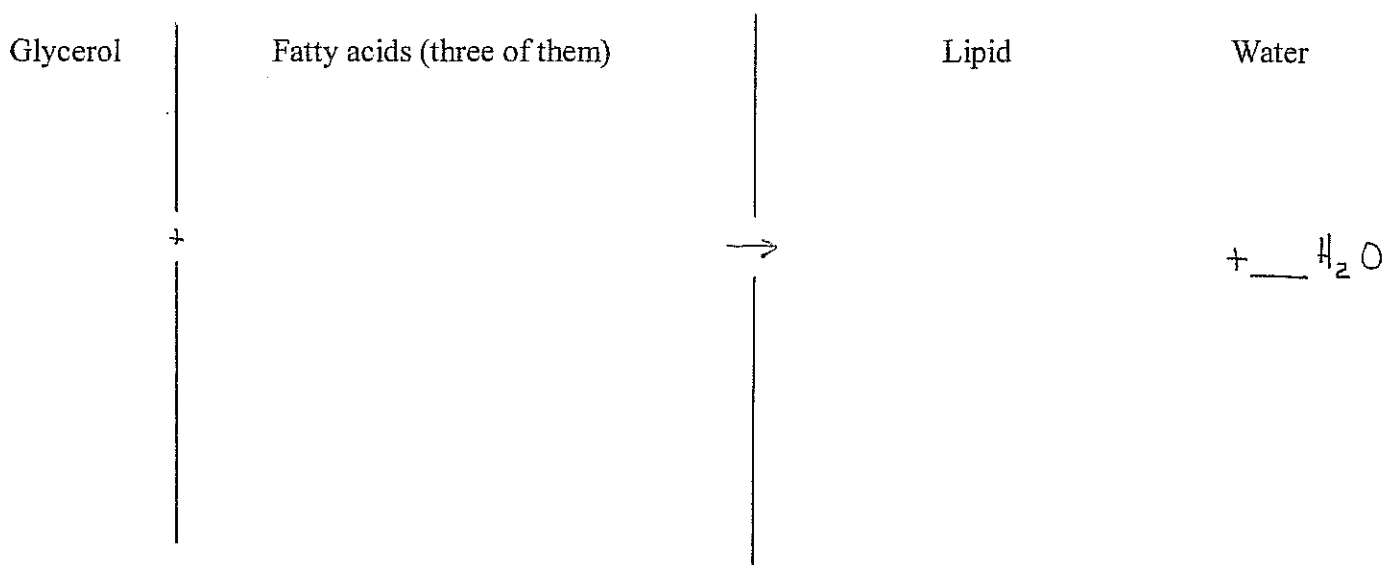
Triglycerides are a type of fat discussed a great deal when talking about \_\_\_\_\_ and \_\_\_\_\_. They consist of three \_\_\_\_\_ attached to a molecule of \_\_\_\_\_.

"Fat" tissue in the body is more properly called \_\_\_\_\_ tissue.

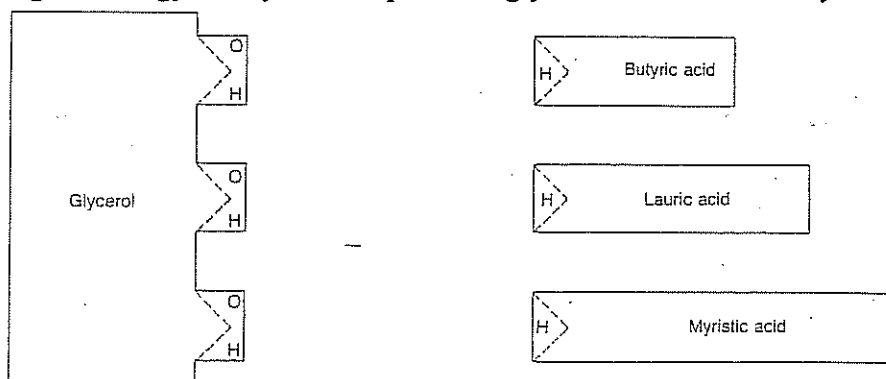
At room temperature, fats are generally \_\_\_\_\_ (Which state of matter?) and are generally found in what type of organism? \_\_\_\_\_

At room temperature, oils are generally \_\_\_\_\_ (What state?) and are usually found in what type of organism? \_\_\_\_\_

Diagram 3 (available in class) shows the structural formulae for the formation of a lipid molecule. Show each part below. Make your drawings fit the space provided.



Lipids are used for the long-term storage of energy. They are composed of glycerol and various fatty acids. Examine the model below:



On the attached sheet you will find models of a glycerol and three fatty acids. Cut them out on the solid lines. To construct a model of a fat molecule, join the models together by removing three OH-ends from the glycerol model and one H-end from each of the fatty acid models. Save the end pieces you remove. Construct your model below: (Show the dehydration synthesis!)

completed \_\_\_\_\_

Note that the end of each fatty acid has a carboxyl group attached. Diagram 4 (available in class) shows three fatty acids. Draw each in the space below. If single bonds exist throughout the carbon chain, the molecule is saturated (a hydrogen is everywhere it can be). If one or more double bonds exist, the molecule is unsaturated.

stearic acid  
(saturated)

oleic acid  
(unsaturated)

linolenic acid  
(polyunsaturated)

#### Lab Activity--

Obtain a piece of brown wrapping paper. This type of paper is called kraft paper. Draw three circles on the paper about the size of a half-dollar. Label the circles 1-3.

Place a drop of water in circle 1 and a drop of vegetable oil in circle 2. Place a small amount (a smear will do) of lard in circle 3. Wait five minutes and hold the paper up to the light. The presence of a translucent spot in a circle is a positive test for fat. Which circle(s) tested positive? \_\_\_\_\_

A more accurate test for fat is to add 2 mL of water to a culture tube and 2 mL of vegetable oil to a second tube. Add two drops of Sudan III to each tube and gently shake. Set the tubes aside for a few minutes. The presence of fat is indicated by a pink color.

Completed \_\_\_\_\_

When done, throw the piece of bag-paper in the trash. Your instructor will tell you how to handle the tubes.

What two types of molecules are needed to form a molecule of fat? \_\_\_\_\_ and \_\_\_\_\_

Give two ways a carbohydrate molecule is similar to a fat molecule:

1. \_\_\_\_\_
2. \_\_\_\_\_

Give two ways a carbohydrate and fat molecule differ:

1. \_\_\_\_\_
2. \_\_\_\_\_

Describe Kraft paper: \_\_\_\_\_

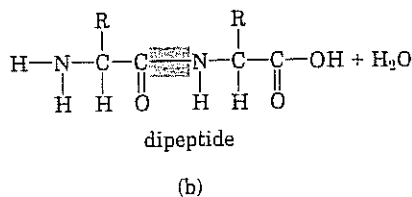
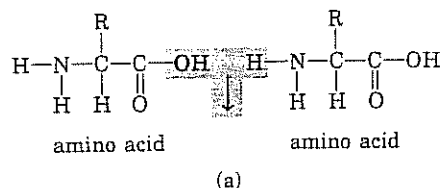
State the function of Sudan III: \_\_\_\_\_

## Proteins and Amino Acids

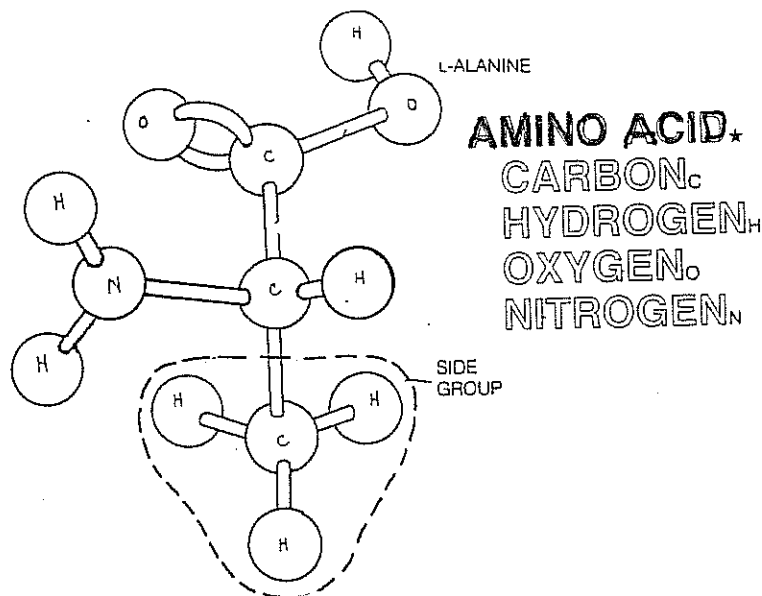
**Proteins** are made up of one or more polypeptides, which are polymers of smaller molecules called **amino acids**. Amino acids derive their name from the amino group and the carboxyl group that each possesses. Polypeptides are formed when amino acids are joined together by peptide bonds between the amino group of one amino acid and the carboxyl group of a second amino acid.

The biuret reagent reacts with peptide bonds and will, therefore, react with proteins, like egg albumin, but will not react with free amino acids, like glycine and alanine.

(a) Structure of an amino acid. Note the presence of an amino ( $-NH_2$ ) group and a carboxyl ( $-COOH$ ) group. (b) Two amino acids are joined by a peptide bond when a molecule of water is "split out" from their amino and carboxyl groups. A polypeptide is made up of many amino acids joined in this way. R represents a side group that is characteristic for each amino acid.

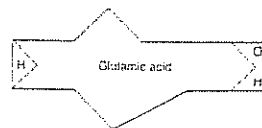
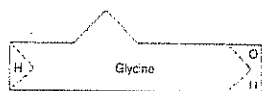


Here is one of the twenty amino acids. It is called L-alanine. Color each type of atom (your choice of colors) along with the name of the atom. Color each bond black. In the spaces to the right of the color diagram draw and label an amino group and a carboxyl group.



Name the two functional groups found in an amino acid: \_\_\_\_\_ and \_\_\_\_\_  
 On both sets of diagrams above, circle the two groups you listed.

Locate the three amino acids on your model sheet.



To construct a model of a protein molecule, join the three models of amino acids as you have done previously with other models to make a molecule of starch and molecule of fat.

Completed \_\_\_\_\_

## TESTING FOR PROTEIN WITH BIURET REAGENT

The biuret reagent is light blue, but in the presence of proteins it turns violet. Other types of molecules may cause other color changes, but only the violet color indicates the presence of polypeptides.

### Procedure

1. Obtain five clean test tubes and use a marker to number them in series from I through 5.
2. To each test tube, add 2 ml of the solution whose number corresponds to the number on the tube.
3. Add one dropper-full (approximately 2 mL) of biuret reagent to each tube.
4. After an incubation period of 2 minutes, record your results in the table below and determine whether the solution treated contains protein. Base your conclusions only on the presence or absence of the violet color.



*Caution:* This is a caustic chemical. It will burn skin and clothing.

Data Table for the Biuret Test

Substance	Color after Two Minutes	Protein Present (+) or Absent (-)
1 Water		
2 Egg Albumin		
3 Potato Starch		
4 Glucose		
5 Gelatine		

completed →

What does this test tell you about the biochemical composition of starch or glucose?

Why has water been included as one of the test substances? \_\_\_\_\_

What elements are present in the protein you constructed? \_\_\_\_\_

What is the name of the process that occurs when amino acids link to form proteins by removing a molecule of water? \_\_\_\_\_

## Identifying Chemical Compounds

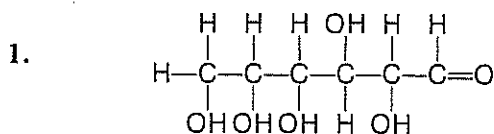
A. Study the rules and formulas below. Then, on the first line under each formula, tell whether the substance is organic or inorganic. On the second line, indicate whether the substance is a carbohydrate, fat or oil, protein or amino acid, or none of these.

- Rules**
1. All organic compounds contain carbon. Most inorganic compounds do not contain carbon. Carbon dioxide is an exception.
  2. In carbohydrate molecules, the ratio of hydrogen to oxygen is 2:1.
  3. In fats and oils, the ratio of hydrogen to oxygen is much greater than 2:1.

4. Amino acids contain an amino group ( $-\text{NH}_2$  or  $\text{N}-\text{H}-$ ) and an organic acid group ( $-\text{COOH}$  or  $-\text{C}-\text{OH}$ )
 

$$\begin{array}{c} \text{N} \\ | \\ -\text{C}-\text{OH} \\ | \\ \text{O} \end{array}$$

**Formulas**




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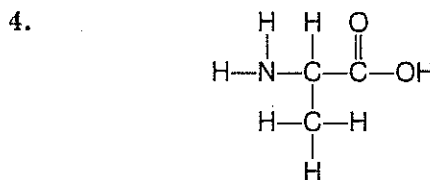
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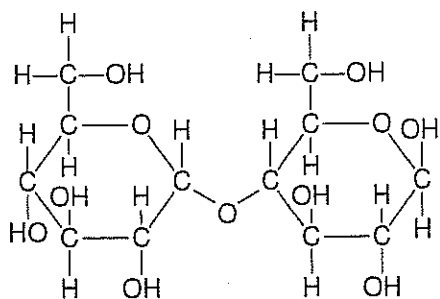



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9.

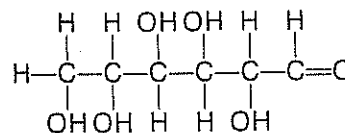



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10.




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11.

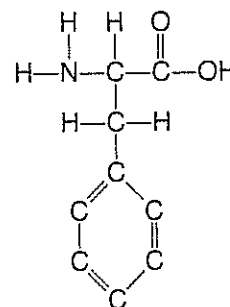



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12.

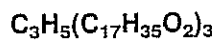



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13.




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### Analysis

Summarize the experiment by completing the following table; list the reagent and identify a positive test for each of the following organic molecules.

Organic molecule	Reagent	Test
Starch		
Simple sugar		
Lipids		
Proteins		

